CsI Crystal Testing: Wrappings and End Treatments

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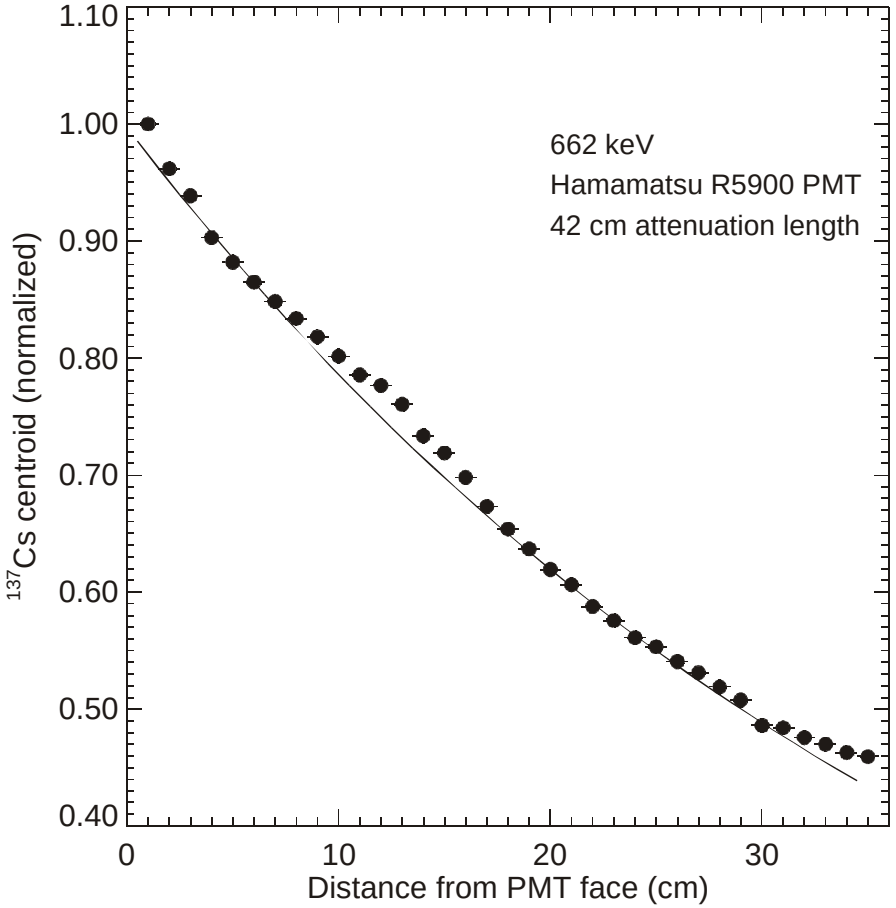
11 February 1999

Position Response of CsI

Map of scintillation in 36 cm CsI crystal.

- Scanned ^{137}Cs source (662 keV).
- Crystal viewed full-face by PMT (connected with optical grease). Far face was blackened.
- Side wrap was Tetratek and aluminized mylar.

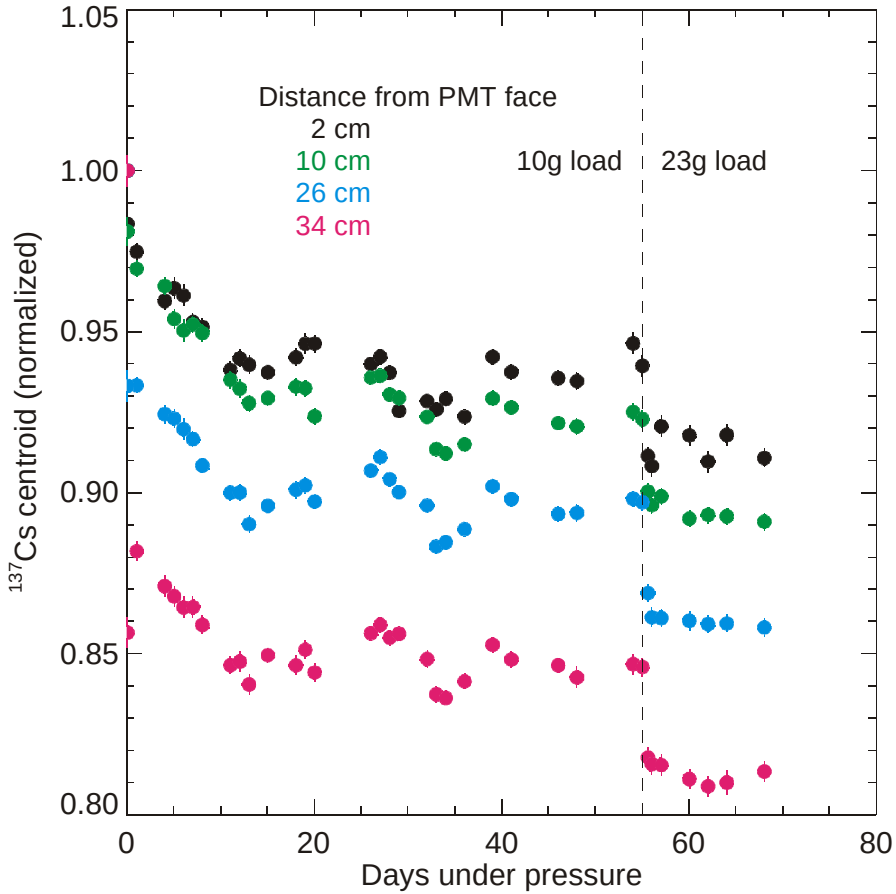
- Scintillation light yield drops by ~ half over length of crystal.
- Solid line is 42-cm exponential attenuation length.
- "Hotspot" at ~ 13 cm is real. ~2-3% magnitude similar to BaBar hotspots.



Long-term Pressure Tests

36-cm crystal, Tetratek and mylar wrap, held under pressure and scanned.

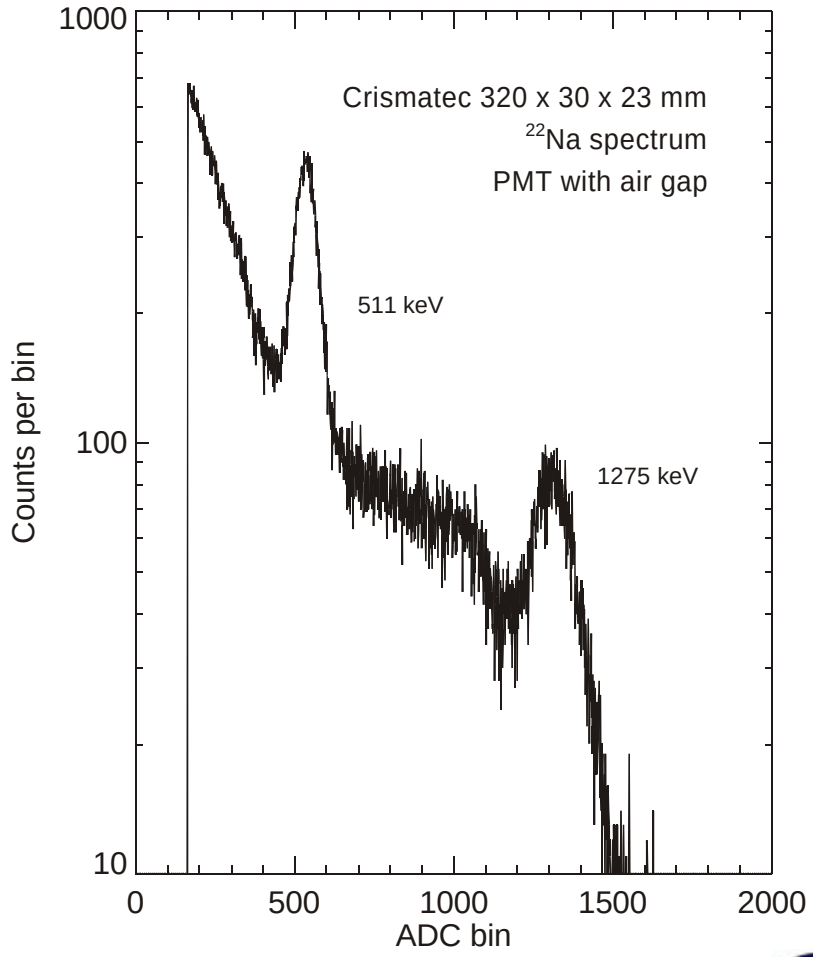
- >50 days of 10-g load on all surfaces.
  - All curves normalized to first measurement.
- Light yield decreases under pressure.
- Light yield stabilizes after ~10 days at ~5 - 15% loss.
- Pressure increased to 23 g.
- Light yield rapidly stabilizes at an additional ~3% loss.



Crystal Test Procedure

- Crystals are numbered and inspected as delivered.
  - Factory wraps are teflon-only or Tyvek and aluminum foil.
  - Additional wrap of aluminized mylar is added if necessary.
- Various end treatments may be applied as required for test.
- Crystal is mounted above 2” PMT.
  - Air gap between crystal and PMT.
- ^{22}Na or ^{137}Cs source is scanned along crystal with motor drive.

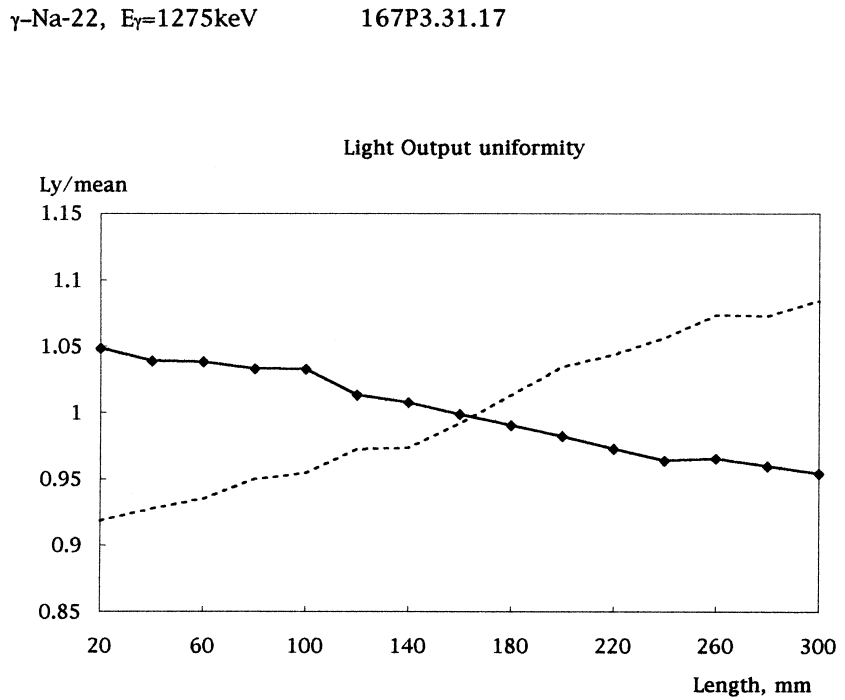
- Good spectroscopy is achieved.



Ukrainian Crystal Tests

- Crystals received from Ukraine
  - Four 310 x 30 x 23 mm
  - Two 400 x 30 x 23 mm

- Test data accumulated at Ukraine.
  - Crystal viewed by PMT with air gap.
  - Surfaces polished and roughened.
  - Wrap is Tyvek and aluminum foil.
  - Far end is Tyvek.
  - ^{22}Na source scanned along length.



White Mask

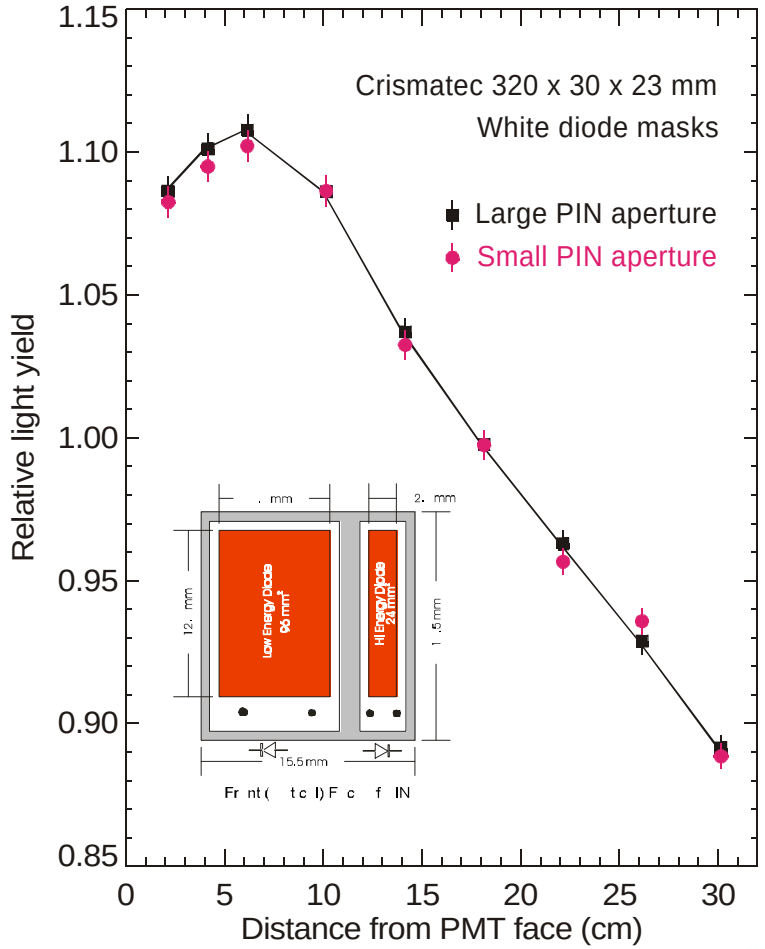
32-cm crystal scanned with ^{22}Na.

- All surfaces polished. Tetratek wrap.
- Viewed by PMT with air gap.

- Near face masked with Tyvek.
- Two masks, different apertures:
  - Size and location of large PIN.
  - Size and location of small PIN.

- Light tapering is independent of aperture size.
- Attenuation length (beyond 10 cm)

  λ = 110 cm.



Black Mask

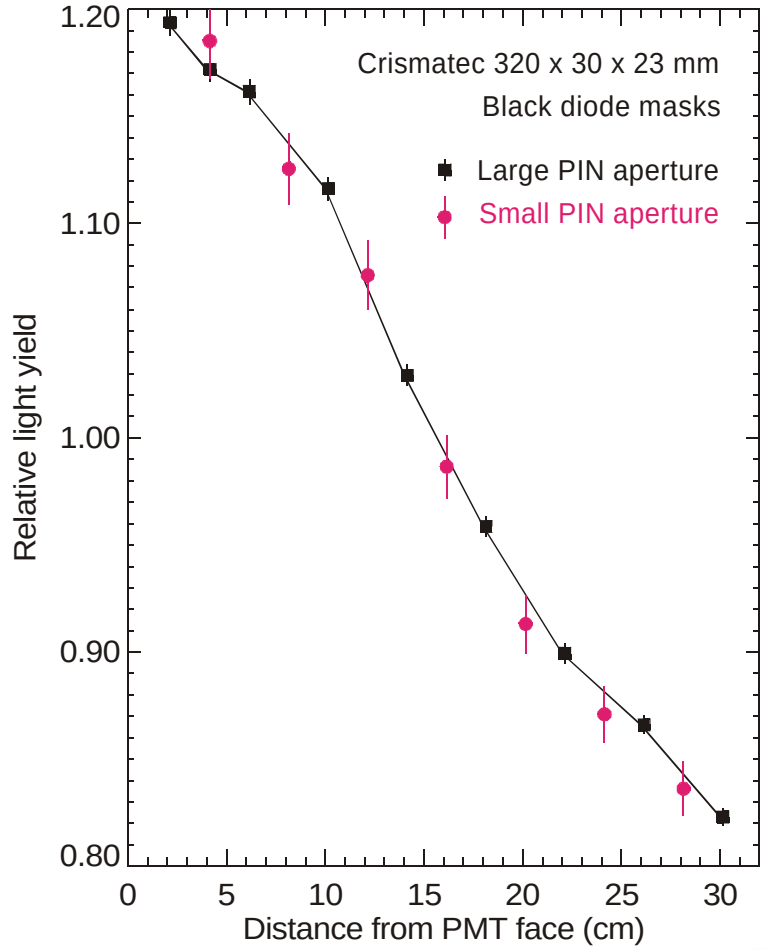
32-cm crystal scanned with ^{22}Na.

- All surfaces polished. Tetratek wrap.
- Viewed by PMT with air gap.

- Near face masked with black paper.
- Two masks, different apertures:
  - Size and location of large PIN.
  - Size and location of small PIN.

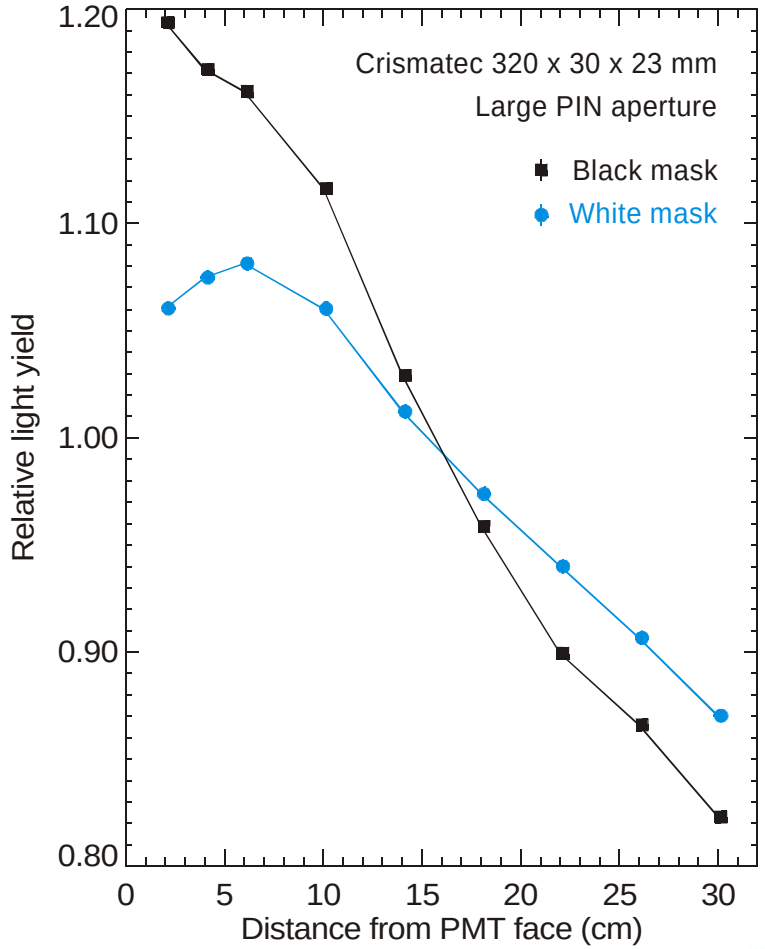
- Light tapering is independent of aperture size.
- Attenuation length (all crystal)

  $\lambda = 75$ cm.



Black or White Ends?

- How does end treatment affect light yield and attenuation?
  - 32-cm Crismatec crystal mapped with ^{22}Na source.
  - PMT readout with black or white aperture mask (~1 cm^2 open).
- Black mask reduces light S to ~2/3 of white mask.
- Black mask shortens attenuation length.
  - λ = 75 cm for black
  - λ = 110 cm for white
- Position resolution scales as $\lambda / \sqrt{S}$
  - Black mask gives
    - 1/3 less light, but
    - 20% better position resolution.



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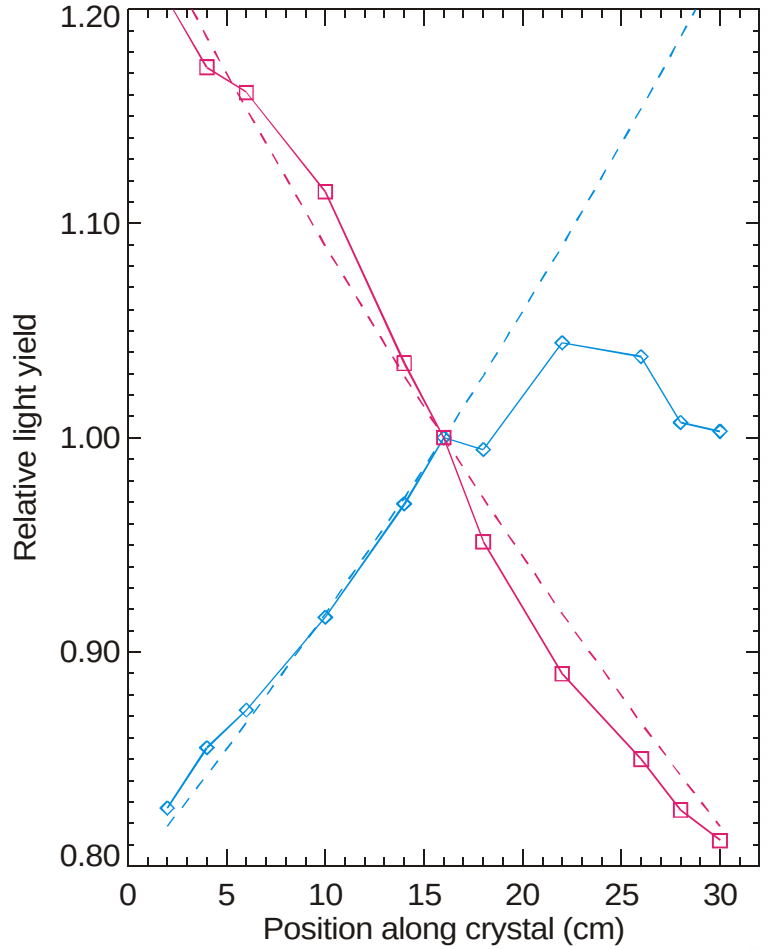
Two-ended Measurements

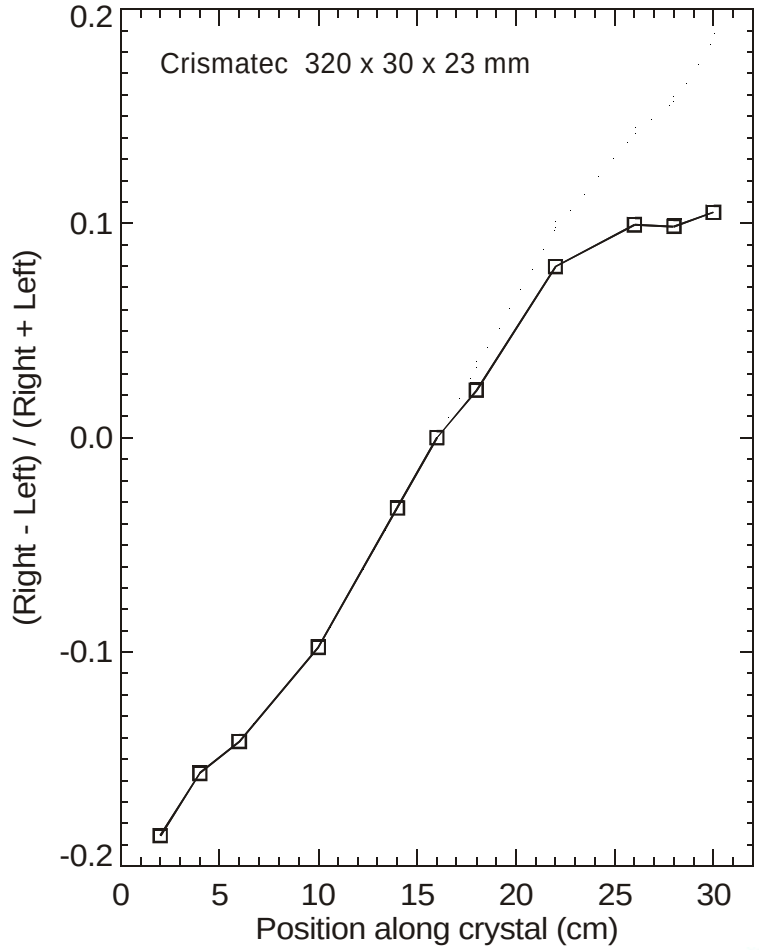
- View crystal from both ends through black mask with aperture of size and location of large PIN.
  - "Red" = Hamamatsu R669 PMT
  - "Blue" = Hamamatsu R5900 PMT
- Both ends show same attenuation length

  $\lambda = 70$ cm
- ooops. Vibration knocked blue PMT out of fixture during run.



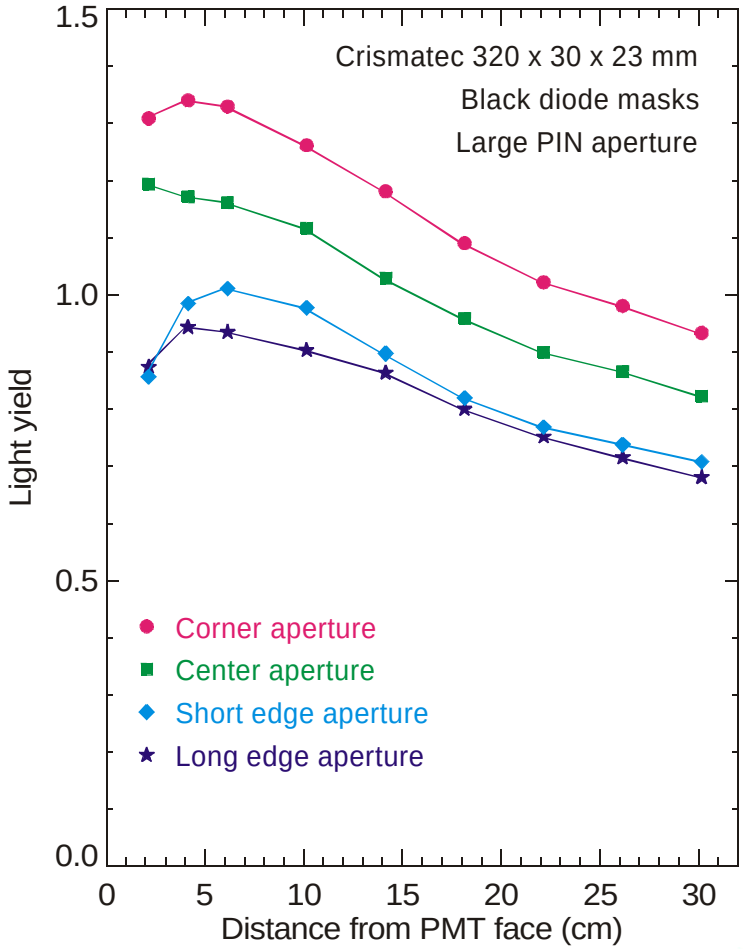
Light Asymmetry

- We use light asymmetry to measure position of shower (or photopeak) along crystal.
- Light asymmetry measure:
  - If attenuation is linear, use
    - $x = 2 \lambda$ (Right-Left) / (Right + Left)
  - If attenuation is exponential, use
    - $x = \lambda \log(\text{Right} / \text{Left})$
- Note that this crystal has twice the slope of the 32-cm crystal used at SLAC and CERN.
  - Will give factor-of-two better position resolution.
- Asymmetry can be readily mapped with lab sources and PMTs.



Location, Location, Location

- We mapped the light yield across the face of the crystal.
  - Varied size and location of aperture across face of crystal.
  - Aperture sized for big PIN at different locations on end face.
- The light yield varies across the end face of the crystal.
  - Center and corners are bright.
  - Sides are dim.
  - Note total effect is only 20-30%.



CERN Beam Test '98